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Title: Precision Surgery and Minimally Invasive Techniques for the Treatment of Complex Biliary Stones Closely Associated with the Middle Hepatic Vein

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Author Questionnaire

1. We have marked your project as author-provided footage, meaning you film the video yourself and provide JoVE with the footage to edit. JoVE will not send the videographer. Please confirm that this is correct.

✓ Correct

2. **Interview statements:** Which interview statement filming option is the most appropriate for your group? **Please select one.**



Interview Statements are read by JoVE's voiceover talent.

Current Protocol Length

Number of Steps: 21

Number of Shots: 46

Interviews

Authors: Please note that **the questions will not appear on screen**. The answers are edited according to journal guidelines.

NOTE to VO producer: Please generate the VO for interviews

INTRODUCTION:

REQUIRED: Summarize your research focus and the main questions it aims to answer.

- 1.1. This protocol demonstrates laparoscopic left hepatectomy using a blunt and sharp combination dissection technique.

1.1.1. B roll: 2.3.1

Describe the research gap or limitation in existing methods and how this protocol addresses them.

- 1.2. Traditional methods rely on extensive dissection or energy devices, increasing the risk of bleeding and bile leakage. This protocol introduces a blunt-and-sharp combination technique to minimize these risks.

1.2.1. B roll: 2.5.1

CONCLUSION:

Describe the most important consideration or challenge when performing this protocol.

- 1.3. Proper preoperative CT scans for mapping the middle hepatic vein are very important. During the surgery, it is crucial to use an ultrasonic scalpel carefully and precisely.

1.3.1. B roll: .3.1.1

What does this protocol allow researchers to measure or study?

- 1.4. This protocol offers guidance to safely treat complex biliary stones involving the middle hepatic vein, ensuring precise anatomical dissection and vascular protection.

1.4.1. B roll: 5.2.1

Ethics Title Card

This research has been approved by the Institutional Review Board at the Shenzhen People's Hospital

Protocol

2. Laparoscopic Access and Cholecystectomy

2.1. After positioning the patient supine on the operating table, establish pneumoperitoneum using an open technique [1]. Then, insert a 10-millimeter camera trocar near the umbilicus and inspect the abdominal cavity [2].

2.1.1. LAB MEDIA: 69831-1 00:08 – 00:20

2.1.2. LAB MEDIA: 69831-1 00:21 – 00:28

2.2. Place the remaining four trocars, including 5 millimeter or 12 millimeter working trocars, in the left upper quadrants for the main surgeon and in the right upper quadrants for the assistant surgeon [1].

2.2.1. LAB MEDIA: 69831-1 00:31 – 00:40

2.3. Expose Calot's triangle [1]. Dissect the cystic duct and cystic artery [2]. Double ligate their proximal ends [3]. Transect the vessels and duct [4].

2.3.1. LAB MEDIA: 69831-1 2:10-2:20

2.3.2. LAB MEDIA: 69831-1 2:50-3:00 and 3:15-3:23

2.3.3. LAB MEDIA: 69831-1 3:20-3:30

2.3.4. LAB MEDIA: 69831-1 4:10-4:14

2.4. Start dissecting the gallbladder from the liver bed [1]. Achieve hemostasis at the liver bed with electrocautery at a power level of 35 watts [2] and completely isolate the gallbladder [3].

2.4.1. LAB MEDIA: 69831-1 05:18 – 05:21 and 07:15-07:20

2.4.2. LAB MEDIA: 69831-1 07:40 – 07:47

2.4.3. LAB MEDIA: 69831-1 08:05 – 08:12

3. Liver Mobilization and Vascular Mapping

3.1. Dissect the ligaments, including the round ligament, falciform ligament [1], and partial left coronary ligament [2].

3.1.1. LAB MEDIA: 69831-1 09:48 – 10:00

3.1.2. LAB MEDIA: 69831-1 18:30 – 18:40

3.2. Identify the root of the middle, right, and left hepatic veins [1]. Mark Cantlie's line with an electrocoagulation hook. Use the line as the imaginary division of the liver, extending from the middle hepatic vein to the midpoint of the gallbladder [2].

3.2.1. LAB MEDIA: 69831-2 12:40 – 12:50 **Author's NOTE: we can see the general direction of veins, but it cannot reveal the complete blood vessels**

3.2.2. LAB MEDIA: 69831-2 13:10 – 13:20

3.3. Perform intraoperative ultrasound in B-mode at 5 megahertz to identify the middle hepatic vein and the bile duct boundary [1]. Use the root of the middle hepatic vein as the anatomical landmark [2]. Then, locate the bile duct boundary, identified by mixed echoes [3]. Apply water to expel air and improve ultrasound conduction [4].

3.3.1. LAB MEDIA: 69831-3 07:15 – 07:25

3.3.2. LAB MEDIA: 69831-3 7:40-7:50

3.3.3. LAB MEDIA: 69831-3 8:04-8:10

3.3.4. LAB MEDIA: 69831-3 08:02 – 08:08

3.4. Implant a number 12 disposable urethral catheter at the first hepatic portal for the Pringle's maneuver [1]. Perform inflow occlusion for 15 minutes and repeat after releasing for 5 minutes [2].

3.4.1. LAB MEDIA: 69831-3 05:32 – 05:40

3.4.2. LAB MEDIA: 69831-3 06:10 – 06:20

3.5. Next, dissect and divide the Left portal vein [1] and arteries of the left liver [2]. Confirm the ischemic demarcation line [3].

3.5.1. LAB MEDIA: 69831-1 5:40-5:50

3.5.2. LAB MEDIA: 69831-1 25:30-25:40 and 28:38-28:44

3.5.3. LAB MEDIA: 69831-2 12:40-12:56

4. Liver Parenchyma Transection Using Blunt-and-Sharp Dissection Technique

- 4.1. Divide the parenchyma along the ischemic demarcation line using an ultrasound scalpel at maximum power level [1] and then clamp, ligate, or perform bipolar coagulation at a power level of 50 watts [2].

4.1.1. LAB MEDIA: 69831-3 09:42 – 09:50

4.1.2. LAB MEDIA: 69831-3 19:15-19:20, 19:35:19:38, 19:48-19:52

- 4.2. Sharply separate the outer layer of the inflamed bile duct with an ultrasonic scalpel using the minimum power level [1].

4.2.1. LAB MEDIA: 69831-3 22:43 – 22:55

- 4.3. Bluntly separate dense tissue adhered to the middle hepatic vein along the sheath plane with an ultrasonic scalpel or laparoscopic suction-irrigation [1].

4.3.1. LAB MEDIA: 69831-5 15:03 – 16:20 and 22:50 – 23:10

- 4.4. Dissect the middle hepatic vein tributaries, including V4b, V4a, and V8 [1]. If a tributary is injured, immediately apply an absorbable hemostatic dressing [2]. Add water over the injured area to prevent carbon dioxide from entering the hepatic vein and reduce the risk of gas embolism [3]. Continue dissection until the middle hepatic vein is completely exposed [4].

4.4.1. LAB MEDIA: 69831-4 16:10 – 16:20, LAB MEDIA: 69831-4 28:55 – 29:05; LAB MEDIA: 69831-4 00:10 – 00:20; LAB MEDIA: 69831-5 06:42 – 06:52 *Video editor: Please display the 4 videos using split screen*

4.4.2. LAB MEDIA: 69831-4 13:33 – 13:42

4.4.3. LAB MEDIA: 69831-4 13:42 – 13:50

4.4.4. LAB MEDIA: 69831-5 20:20-20:40

- 4.5. Use an endoscopic linear cutting stapler with a white hepatic pedicle cartridge to completely divide the left portal vein [1]. Then, use a blue vascular cartridge to divide the left hepatic vein and complete the transection by dividing the left hepatic bile duct [2].

4.5.1. LAB MEDIA: 69831-6 16:20 – 16:26

4.5.2. LAB MEDIA: 69831-6 14:40 – 14:50

5. Choledocholithotomy and Post-Resection Management

5.1. Place a 12 millimeter trocar for a subxiphoid port [1].

5.1.1. LAB MEDIA: 69831-2 21:30 – 21:40

5.2. Insert a retrieval basket through the choledochoscope to remove intrahepatic and extrahepatic bile duct stones via the left hepatic bile duct end. Continue until all stones are cleared [1].

5.2.1. LAB MEDIA: 69831-2 21:59 – 22:10, 69831-3 04:00 – 04:20

5.3. Close the left bile duct end using PDS synthetic absorbable surgical sutures [1].

5.3.1. LAB MEDIA: 69831-7 02:40 – 02:45, 10:30 – 10:35

5.4. Place a 22-French T-tube in the common bile duct from the subxiphoid port for external drainage [1].

5.4.1. LAB MEDIA: 69831-8 08:50 – 09:00, 20:13 – 20:18

5.5. Confirm the post-resection anatomy and achieve hemostasis on the section surface [1]. Then, detect bile leakage using the white gauze test [2].

5.5.1. LAB MEDIA: 69831-8 20:31 – 20:40

5.5.2. LAB MEDIA: 69831-8 24:12 – 24:20

5.6. Place one drainage tube next to the section surface [1]. Position a second drainage tube in the foramen of Winslow, and secure both to the skin to prevent dislodgement [2]. Finally, remove the trocars and close the abdominal incisions [3].

5.6.1. LAB MEDIA: 69831-8 26:10 – 26:15

5.6.2. LAB MEDIA: 69831-8 27:50 – 28:05

5.6.3. LAB MEDIA: 69831-8 28:29 – 28:32

Results

6. Results

6.1. The preoperative CT image showed left and right hepatic bile duct stones in a patient with left liver atrophy, left hepatic duct stenosis, and extrahepatic bile duct stones. The stones were closely associated with the middle hepatic vein [1-TXT].

6.1.1. LAB MEDIA: Figure 4A. *Video editor: Show the pre-operative CT image in panel A.* **TXT: CT: Computed Tomography**

6.2. The patient underwent laparoscopic left hepatectomy [1] with a total operative time of 290 minutes [2]. The estimated blood loss was 50 milliliters [3].

6.2.1. LAB MEDIA: Table 1.

6.2.2. LAB MEDIA: Table 1. *Video editor: Highlight the row "Duration of Operation" and the value "290 min."*

6.2.3. LAB MEDIA: Table 1. *Video editor: Highlight the row "Blood loss" and the value "50 mL."*

6.3. The patient was discharged on post-operative day 6 without major adverse events [1].

6.3.1. LAB MEDIA: Table 1. *Video editor: Highlight the row "Hospital Stay" and the value "6 Days."*

6.4. The patient's liver function was normal after the operation. A CT scan performed 6 months later showed [1] only a 2-millimeter residual stone at the terminal end of the right posterior lobe bile duct, which could not be reached by choledochoscopy [2].

6.4.1. LAB MEDIA: Figure 4B.

6.4.2. LAB MEDIA: Figure 4B. *Video editor: Highlight the white spot*

1. Laparoscopic

Pronunciation link: <https://www.merriam-webster.com/dictionary/laparoscopic>

IPA: /ləpərə'skɑ:pɪk/

Phonetic Spelling: lap·uh·ruh·skaa·pik

2. Cholecystectomy
Pronunciation link: <https://www.merriam-webster.com/dictionary/cholecystectomy>
IPA: /ˌkɒləsɪˈstektəmi/
Phonetic Spelling: koh·luh·sih·stek·tuh·mee
3. Pneumoperitoneum
Pronunciation link: <https://www.merriam-webster.com/dictionary/pneumoperitoneum>
IPA: /ˌnuːmoʊˌperɪtəˈniːəm/
Phonetic Spelling: noo·moh·peh·ruh·tuh·nee·uhm
4. Trocar
Pronunciation link: <https://www.merriam-webster.com/dictionary/trocar>
IPA: /ˈtroʊˌkɑːr/
Phonetic Spelling: troh·kar
5. Umbilicus
Pronunciation link: <https://www.merriam-webster.com/dictionary/umbilicus>
IPA: /ʌmˈbɪlɪkəs/
Phonetic Spelling: um·bil·ih·kuhs
6. Calot
Pronunciation link: <https://www.howtopronounce.com/calot>
IPA: /kæˈloʊ/
Phonetic Spelling: ka·LOH
7. Cystic
Pronunciation link: <https://www.merriam-webster.com/dictionary/cystic>
IPA: /ˈsɪstɪk/
Phonetic Spelling: sis·tik
8. Ligate
Pronunciation link: <https://www.merriam-webster.com/dictionary/ligate>
IPA: /ˈlaɪˌɡeɪt/
Phonetic Spelling: lie·gayt
9. Transect
Pronunciation link: <https://www.merriam-webster.com/dictionary/transect>
IPA: /trænˈsekt/
Phonetic Spelling: tran·sekt
10. Hemostasis
Pronunciation link: <https://www.merriam-webster.com/dictionary/hemostasis>
IPA: /ˌhiːməˈsteɪsɪs/
Phonetic Spelling: hee·muh·stay·suhs
11. Electrocautery
Pronunciation link: <https://www.merriam-webster.com/dictionary/electrocautery>
IPA: /ɪˌlektroʊˈkɔːtəri/
Phonetic Spelling: ih·lek·troh·kaw·tuh·ree
12. Falciform
Pronunciation link: <https://www.merriam-webster.com/dictionary/falciform>
IPA: /ˈfælsəˌfɔːrm/
Phonetic Spelling: fal·suh·form

13. Coronary
Pronunciation link: <https://www.merriam-webster.com/dictionary/coronary>
IPA: /'kɔ:rə,neri/
Phonetic Spelling: kor·uh·ner·ee
14. Hepatic
Pronunciation link: <https://www.merriam-webster.com/dictionary/hepatic>
IPA: /hɪ'pætɪk/
Phonetic Spelling: hih·pat·ik
15. Cantlie
Pronunciation link: <https://www.howtopronounce.com/cantlie>
IPA: /'kæntli/
Phonetic Spelling: kant·lee
16. Electrocoagulation
Pronunciation link: <https://www.merriam-webster.com/dictionary/electrocoagulation>
IPA: /ɪ,lektroʊkoʊ,æɡjə'leɪʃən/
Phonetic Spelling: ih·lek·troh·koh·ag·yuh·lay·shuhn
17. Intraoperative
Pronunciation link: <https://www.merriam-webster.com/dictionary/intraoperative>
IPA: /,ɪntrə'ɑ:pəreɪtɪv/
Phonetic Spelling: in·truh·op·uh·ruh·tiv
18. Ultrasound
Pronunciation link: <https://www.merriam-webster.com/dictionary/ultrasound>
IPA: /'ʌltrə,saʊnd/
Phonetic Spelling: ul·truh·sound
19. Megahertz
Pronunciation link: <https://www.merriam-webster.com/dictionary/megahertz>
IPA: /'megə,hɜ:ts/
Phonetic Spelling: meg·uh·hurts
20. Anatomical
Pronunciation link: <https://www.merriam-webster.com/dictionary/anatomical>
IPA: /,ænə'tɑ:mɪkəl/
Phonetic Spelling: an·uh·taa·mih·kuhl
21. Urethral
Pronunciation link: <https://www.merriam-webster.com/dictionary/urethral>
IPA: /jʊ'ri:θrəl/
Phonetic Spelling: yoo·ree·thruhl
22. Pringle
Pronunciation link: <https://www.merriam-webster.com/dictionary/Pringle>
IPA: /'prɪŋɡəl/
Phonetic Spelling: pring·guhl
23. Ischemic
Pronunciation link: <https://www.merriam-webster.com/dictionary/ischemic>
IPA: /ɪ'ski:mɪk/
Phonetic Spelling: ih·skee·mik

24. Parenchyma
Pronunciation link: <https://www.merriam-webster.com/dictionary/parenchyma>
IPA: /pəˈrɛŋkəmə/
Phonetic Spelling: puh·rɛng·kuh·muh
25. Bipolar
Pronunciation link: <https://www.merriam-webster.com/dictionary/bipolar>
IPA: /baɪˈpɒlər/
Phonetic Spelling: bye·poh·ler
26. Coagulation
Pronunciation link: <https://www.merriam-webster.com/dictionary/coagulation>
IPA: /koʊˌæɡjəˈleɪʃən/
Phonetic Spelling: koh·ag·yuh·lay·shuhn
27. Ultrasonic
Pronunciation link: <https://www.merriam-webster.com/dictionary/ultrasonic>
IPA: /ˌʌltrəˈsɑːnɪk/
Phonetic Spelling: ul·truh·son·ik
28. Tributaries
Pronunciation link: <https://www.merriam-webster.com/dictionary/tributary>
IPA: /ˈtrɪbjəˌteri/
Phonetic Spelling: trib·yuh·ter·ee
29. Absorbable
Pronunciation link: <https://www.merriam-webster.com/dictionary/absorbable>
IPA: /əbˈzɔːrəbəl/
Phonetic Spelling: ub·zor·buh·buhl
30. Embolism
Pronunciation link: <https://www.merriam-webster.com/dictionary/embolism>
IPA: /ˈembəˌlɪzəm/
Phonetic Spelling: em·buh·lih·zuhm
31. Endoscopic
Pronunciation link: <https://www.merriam-webster.com/dictionary/endoscopic>
IPA: /ˌɛndəˈskaːpɪk/
Phonetic Spelling: en·duh·skaa·pik
32. Stapler
Pronunciation link: <https://www.merriam-webster.com/dictionary/stapler>
IPA: /ˈsteɪplər/
Phonetic Spelling: stay·pler
33. Choledocholithotomy
Pronunciation link: <https://www.merriam-webster.com/dictionary/choledocholithotomy>
IPA: /kəˌlɛdəkoʊlɪˈθɑːtəmi/
Phonetic Spelling: kuh·led·oh·koh·luh·THOT·uh·mee
34. Choledochoscopy
Pronunciation link: <https://www.merriam-webster.com/dictionary/choledochoscopy>
IPA: /kəˌlɛdəˈkɑːskəpi/
Phonetic Spelling: kuh·led·oh·KOS·kuh·pee

35. Intrahepatic
Pronunciation link: <https://www.merriam-webster.com/dictionary/intrahepatic>
IPA: /ˌɪntrəˈhiːpætɪk/
Phonetic Spelling: in·truh·hih·pat·ik
36. Extrahepatic
Pronunciation link: <https://www.merriam-webster.com/dictionary/extrahepatic>
IPA: /ˌɛkstrəˈhiːpætɪk/
Phonetic Spelling: eks·truh·hih·pat·ik
37. Retrieval
Pronunciation link: <https://www.merriam-webster.com/dictionary/retrieval>
IPA: /rɪˈtriːvəl/
Phonetic Spelling: rih·tree·vuhl
38. PDS
Pronunciation link: No confirmed link found
IPA: /ˌpiː diː ˈɛs/
Phonetic Spelling: pee·dee·ess
39. Subxiphoid
Pronunciation link: <https://www.merriam-webster.com/dictionary/xiphoid>
IPA: /ˌsʌbˈzɪfɔɪd/
Phonetic Spelling: sub·ZYE·foyd
40. Foramen
Pronunciation link: <https://www.merriam-webster.com/dictionary/foramen>
IPA: /fəˈreɪmən/
Phonetic Spelling: fuh·RAY·muhn
41. Winslow
Pronunciation link: <https://www.howtopronounce.com/winslow>
IPA: /ˈwɪnzloʊ/
Phonetic Spelling: winz·loh
42. Stenosis
Pronunciation link: <https://www.merriam-webster.com/dictionary/stenosis>
IPA: /stəˈnoʊsɪs/
Phonetic Spelling: stuh·NOH·suhs
43. Atrophy
Pronunciation link: <https://www.merriam-webster.com/dictionary/atrophy>
IPA: /ˈætɹəfi/
Phonetic Spelling: a·truh·fee
44. Tomography
Pronunciation link: <https://www.merriam-webster.com/dictionary/tomography>
IPA: /təˈmɑːɡrəfi/
Phonetic Spelling: tuh·MAA·gruh·fee